
Influence of operator experience on canal preparation time when using the rotary Ni-Ti ProFile system in simulated curved canals

C. Mesgouez, F. Rilliard, L. Matossian, K. Nassiri & E. Mandel

Endodontic Department, School of Dentistry, University Paris 7, Paris, France

Abstract

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Aim The aim of this study was to determine the influence of operator experience on the time needed for canal preparation when using a rotary nickel-titanium (Ni-Ti) system.

Method A total of 100 simulated curved canals in resin blocks were used. Four operators prepared a total of 25 canals each. The operators included practitioners with prior experience of the preparation technique, and practitioners with no experience. The working length for each instrument was precisely predetermined. All canals were instrumented with rotary Ni-Ti ProFile Variable

Taper Series 29 engine-driven instruments using a high-torque handpiece (Maillefer, Ballaigues, Switzerland). The time taken to prepare each canal was recorded. Significant differences between the operators were analysed using the Student's *t*-test and the Kruskal–Wallis and Dunn nonparametric tests.

Results Comparison of canal preparation times demonstrated a statistically significant difference between the four operators ($P < 0.001$). In the inexperienced group, a significant linear regression between canal number and preparation time occurred.

Conclusion Time required for canal preparation was inversely related to operator experience.

Keywords: nickel-titanium, root canal preparation, rotary files, simulated canals.

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Introduction

The instrumentation of curved canals is facilitated by the use of nickel-titanium (Ni-Ti) endodontic instruments. Their principal value lies in their flexibility and their ability to repeatedly recover from minor distortion (Walia *et al.* 1988). This flexibility is an important property because it facilitates preparations of curved canals whilst minimizing procedural accidents generally associated with stainless steel instruments larger than size 30 (Esposito & Cunningham 1995). Many studies (Bou Dagher & Yared 1995, Zmener & Balbachan 1995, Lodd Tharuni *et al.* 1996, Bishop & Dummer 1997) have shown that more centred and better tapered preparations were

obtained with the use of Ni-Ti files compared with stainless steel files.

The low modulus of elasticity of Ni-Ti has allowed instruments to be manufactured for use with rotary canal preparation techniques (Glosson *et al.* 1995). Generally, studies show that canal shape is maintained by rotary ProFiles Ni-Ti instrument and their use has proven to be time saving (Thompson & Dummer 1997a,b). In spite of their superior flexibility, instrument breakage is still a matter of concern (Zuolo & Walton 1995). Several recent studies on ProFile instruments have reported their canal-centering ability, but the prevalence of instrument breakage can still approach 9.4% (Baumann & Roth 1999).

In a previous study (Mandel *et al.* 1999), the effect of the operator on ProFile rotary Ni-Ti instrument fracture was evaluated. The results indicated that a greater number of instruments failed during the 'learning period'

Correspondence: Dr Catherine Mesgouez, Endodontic Department, School of Dentistry, University Paris 7, 5, Rue Garancière, Paris 75006, France (e-mail: catherine.menez@free.fr).

than during the 'application period'. This confirmed the necessity of mastering this rotary canal preparation technique, and the importance of improving competence through learning and experience.

The aim of this study was to determine the effect of operator experience on canal preparation time.

Materials and methods

Manufactured simulated curved root canals in clear casting resin with a standardized canal shape (Dentsply Maillefer, Ballaigues, Switzerland) were used as described in a previous publication (Mandel *et al.* 1999). The apical extent of the canal was opened on the side of the resin block; it had a diameter of 0.1 mm. The coronal orifice had a diameter of 0.5 mm. A conical depression was present at the coronal orifice (3 mm diameter; 5 mm deep); canal length was 21 mm. The canals were manufactured in such a way that they all had round cross-sections, and the same geometric proportions including radius of curvature, angle of the curvature, coronal access orifice and apical orifice diameter. The radius of curvature and the angle of the curvature were determined (Pruett *et al.* 1997); all had an angle of curvature equal to 50° and a radius of curvature equal to 6.5 mm (Mandel *et al.* 1999).

One hundred specimens were used and divided into four groups: A, B, C and D, each consisting of 25 canals. Each group was instrumented by a different operator; two were inexperienced whilst two others were experienced. The experienced operators had perfected the technique through daily use over a period of 2 years. The inexperienced operators knew the theory of the technique without having used it in daily practice. All canals were instrumented with rotary Ni-Ti ProFile Variable Taper Series 29 System engine-driven instruments using a high-torque handpiece (Maillefer, Ballaigues, Switzerland). Instruments were manipulated at a speed of 300 r.p.m., and all groups used the crown down sequence during preparation.

Copious irrigation with water was performed after the use of each instrument using disposable syringes (Monoject, Ballymoney, N. Ireland) and 27 gauge irrigating tips (Endo-Tips, Ultradent Products Inc., Utah, UT, USA). Approximately 25 mL of water was used per canal. Prior to use, each file was coated with RC-Prep (Premier Dental Products Co., Philadelphia, PA, USA) to act as a lubricant. Files were wiped regularly on a sponge to remove resin debris.

The patency of the apical orifice was then checked at the end of the instrumentation with the ProFile 04/15.

In case of failure, root canal patency was obtained with a size 10 pathfinder manual precurved K-File.

Instrumentation of simulated canals

All instruments were used for the preparation of only two samples, and then changed. The instruments were used with a rubber stop, and canal instrumentation ended when length was achieved. The instrumentation sequence used for shaping specimens was identical for all groups. The working length for each instrument was precisely predetermined. Using crown down motion, these were as follows:

- ProFile Orifice Shaper 3: 13 mm from the orifice.
- ProFile Orifice Shaper 2: 15 mm from the orifice.
- ProFile .06/25: 17 mm from the orifice.
- ProFile .06/20: 19 mm from the orifice.
- ProFile .04/25: 20 mm from the orifice.
- ProFile .04/20: patency of the orifice.

The practitioners noted the time required for canal preparation of each simulated canal. This time was calculated from the penetration of the first instrument, i.e. ProFile Orifice Shaper 3, to the use of the final one, i.e. ProFile .04/20.

Statistical analysis

The statistical significance between groups was analysed using Student's *t*-tests. Because dispersion values for operator C (SD = 49.61) differed from other operators ($P < 0.05$), quantitative comparison of variables was undertaken using Kruskal–Wallis and Dunn non parametric tests. Data were entered on Microsoft® Excel 97 software. JANDEL Corp® SigmaStat v2.0 software was used for statistical analysis. Microsoft® Graph 2000 was used for graphic drawings. Variable distribution was analysed using the normality test of Kolmogorov–Smirnov. Distribution comparisons used Chi-square Pearson's test. Fisher's ANOVA test was used for linear regression analysis.

Results

The mean preparation time for all specimens was 2 min 42 s per canal (SD = 58 s); the median value was 2 min 27 s. Mean and median times were, respectively, 2 min 12 s (SD = 26 s) and 2 min 12 s for operator A, 2 min 26 s (SD = 26 s) and 2 min 25 s for operator B, 4 min 01 s (SD = 50 s) and 4 min 07 s for operator C and 2 min 10 s (SD = 38 s) and 2 min 14 s for operator D (Table 1). Kruskal–Wallis one-way ANOVA on ranks

Table 1 Mean operating time by operator

	Operators			
	A	B	C	D
Mean time (seconds)	132.12	146.4	240.56	129.76
Standard deviation	26.07	25.79	49.61	38.12
Normality test (Kolmogorov Smirnov)	Passed	Passed	Failed ($P = 0.003$)	Passed

showed statistically significant differences between median values for the four operators ($P < 0.001$). All pair-wise multiple comparison procedures, according to Dunn's method, showed statistically significant differences between operators C versus A ($P < 0.05$), C versus B ($P < 0.05$) and C versus D ($P < 0.05$). Comparisons between other groups did not show statistically signifi-

cant differences. Figure 1 outlines the variation in operating time by canal number.

Operator A (experienced)

There was no significant correlation between canal number and preparation times ($r = 0.249$; $P = 0.25$). Learning with time did not occur with operator A (Table 2).

Operator B (experienced)

There was a significant linear regression between canal number and preparation time ($r = 0.598$; $P = 0.002$). Canal number explained 33% of time variability. Learning progress with time occurred with this operator (Table 2).

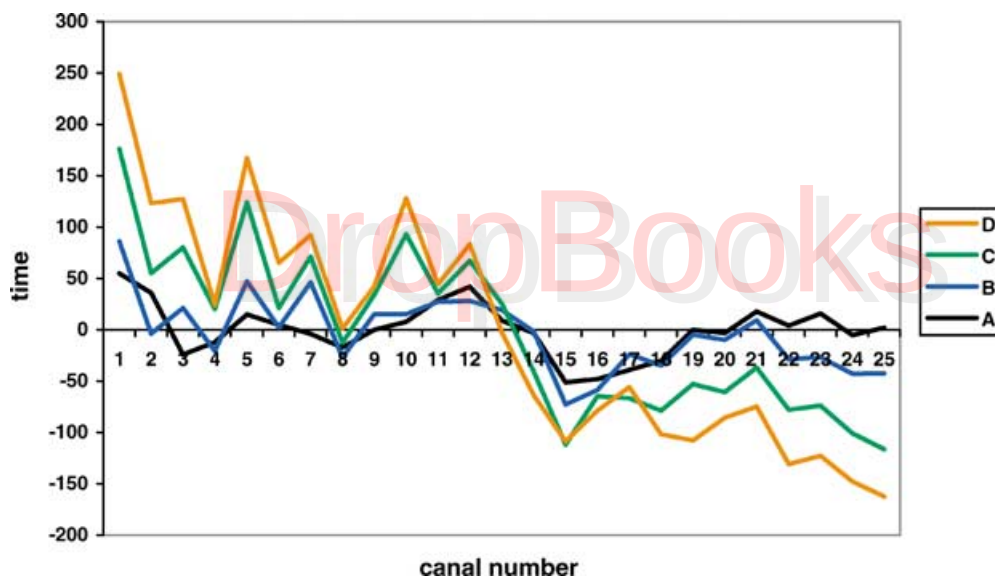


Figure 1 Differences for the mean results of each operator relating to operating times. A and B: Experienced practitioners; C and D: Inexperienced practitioners.

Table 2 Canals distribution according to number of differences related to experienced and inexperienced operators

	Experienced group (A + B)		Inexperienced group (C + D)	
	Mean differences less than 0	Mean differences higher than 0	Mean differences less than 0	Mean differences higher than 0
First 12 canals	12	14	0	24
Last 13 canals	15	11	23	3

Operator C (inexperienced)

There was a significant linear regression between canal number and preparation time for operator C ($r = 0.911$; $P < 0.001$). Canal number explained 82.3% time variability.

Operator D (inexperienced)

There was a significant linear regression between canal number and preparation time for operator D ($r = 0.908$; $P < 0.001$). Canal number explained 81.6% of time variability. Two distinct practitioner groups based on their technical experience were differentiated (Table 2).

Discussion

The aim of this study was to evaluate the influence of clinical experience on the time required for shaping root canals with the ProFile rotary instrumentation technique. In a previous study, Mandel *et al.* (1999) identified the events that could explain instrument fracture during the shaping of root canals with ProFile instruments. They showed that, when other factors such as geometry of the canal, instrument sequence and rotary speed were constant, the operator's ability and experience were important factors in instrument failure. That study also identified two different periods: the 'learning period' and the 'application period' (see Fig. 2).

The present study was based on the premise that the most important factor was not the duration of each instrument passage but its length of penetration. The advantage of this experimental method was to render the shaping ability of the instrument uniform for all

operators. Indeed, the 'penetration level' factor tended to consider the pressure applied on the instrument during shaping as being important. This pressure can obviously differ between various operators. However, ProFile instruments are more efficient with a decreasing movement which optimizes deeper penetration in the canal. This allows the operator's own pressure to be eliminated. In the present study, besides the preparation time for each simulated canal, we also studied the evolution of operating time during the preparation of 25 samples in relation to the level of clinical experience of each practitioner. The results showed variations of preparation time according to the clinical expertise of the operator.

For experienced operators A and B, distribution of operating times above the mean for the first 12 canals did not statistically differ from operating times for the last 13 canals ($P = 0.25$). Whereas, the nonexperienced group (C + D) showed that greater than mean values for the first 12 canals were more numerous than for the last 13 canals ($P < 0.001$).

In the case of operator A, there was no statistically significant correlation between the number of simulated canals already prepared and the operating times. Unlike the three other operators, this operator neither gained nor lost time between the first and the last sample.

When comparing the values obtained for the four operators during the preparation of the 25 samples (Fig. 1), the results showed two distinct periods. Indeed, for two operators (C and D), the time necessary for canal preparation decreased during the preparation of the second half of the samples. The similarity was less clear for operators A and B (experienced practitioners).

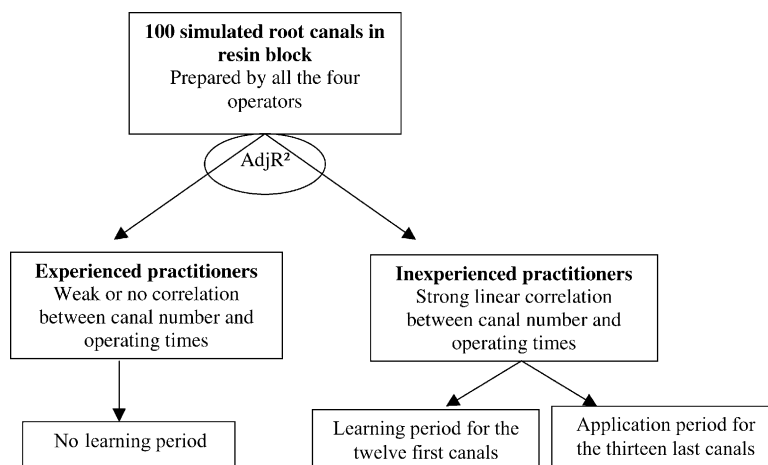


Figure 2 Outcome of study in diagrammatic format.

Conclusion

When all other variables remain constant, i.e. geometry of the canal, instrument sequence and rotary speed, the operator's experience was an important factor in terms of the duration of each canal preparation. This difference was found statistically significant ($P < 0.001$) in the group of inexperienced practitioners (C and D). In this group, the time necessary for canal instrumentation decreased during preparation of the second half of the samples.

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